ONTARIO WATER RESOURCES COMMISSION

AN INVESTIGATION OF WATER QUALITY IN THE CALEDON MOUNTAIN TROUT CLUB PONDS

1971

An Investigation of Water Quality In The Caledon Mountain Trout Club Ponds

Peel County

Caledon Township

D. Veal and I. Wile

Biology Branch
Ontario Water Resources Commission

September, 1971

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INTRODUCTION

On July 9, 1971, staff of the Biology Branch of the Ontario Water Resources Commission investigated the water quality of trout ponds located on the property of the Caledon Mountain Trout Club. The investigation was in response to a request from Mr. Jennings, Chairman of the Pollution Committee of the club, to have an assessment made of ponds with respect to their suitability for trout production and recreational useage. Members of the Caledon Mountain Trout Club had apparently collected several samples for bacterial analyses and Mr. Jennings felt that some of the results indicated that at least one of the ponds was contaminated. Also, there were reports of a lack of dissolved oxygen and a low pH value in the ponds.

METHODS

Field measurements of pH, dissolved oxygen and conductivity were made using a Hach Engineering Field Kit. Temperature measurements were made using a telethermometer and secchi disc readings were taken using an eight inch diameter standard secchi disc. Samples for analyses of phosphorus, nitrogen and hardness were collected using a Kemmerer water sampler and were placed in 32-oz. glass water bottles for testing at the Rexdale laboratory. Samples for bacteriological analyses were collected using sterile glass bottles and were tested at the Rexdale laboratory three days after collection.

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DISCUSSION OF RESULTS

Due to natural fluctuations in chemical and biological characteristics of water, the number of conclusions that can be drawn from a single set of data are limited. In this report, the interpretation of results will therefore be of a general nature.

Bacteriological

Appendix II illustrates the bacteriological results of the two samples collected - one near the outlet of pond #1 and the second from the creek just upstream from pond #1. Except for the fecal streptococcus count in one sample, the results are well within the OWRC* standards for recreational waters. Levels of fecal streptococcus frequently exceed the standards in ponds that are not affected by artificial pollution.

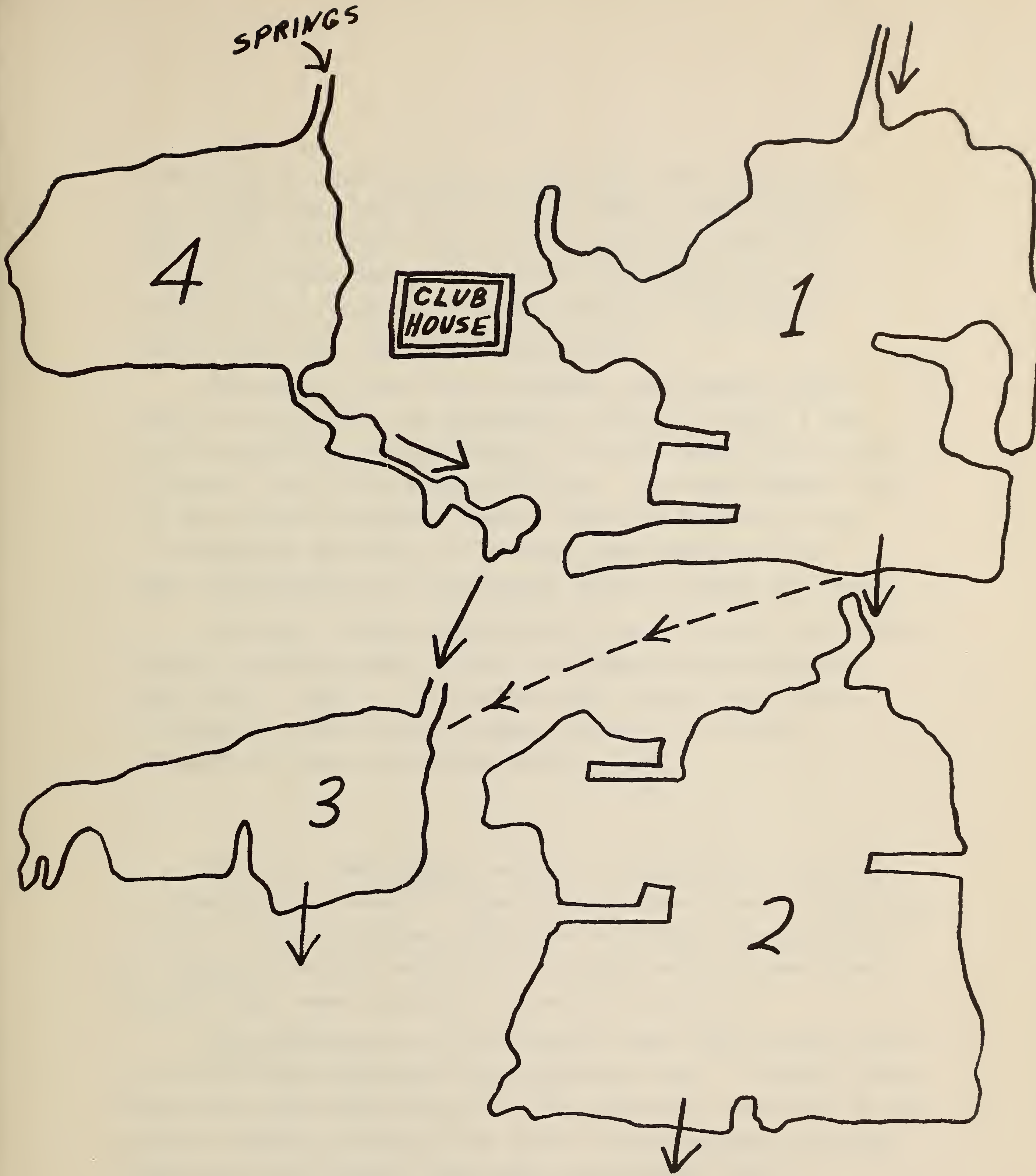
Physical, chemical and biological

In general, the results indicate that the ponds are suitable (although certainly not ideal) for trout production.

Phosphorus and Nitrogen

Nitrogen and phosphorus are essential plant nutrients and their concentrations to a large degree regulate the

* recreational waters can be considered impaired when the coliform, fecal coliform and/or fecal streptococcus geometric mean densities exceeds 1000, 100 and/or 20 per 100 ml. respectively, in a series of at least 10 samples per month, including samples collected during week-end periods.



A Rough Sketch Of The Caledon Mountain Trout Club Ponds

production of aquatic plants (algae and vascular plants). While algae form the basis of food chains and therefore have great ecological importance, excessive levels of nitrogen and phosphorus frequently bring about an over-production of algae and related problems - turbidity, oxygen depletion, aesthetic impairment.

Analyses on the July 9 samples (see Appendix III) indicate that while the phosphorus levels in ponds 1 and 2 are reasonably low and typical of trout ponds, the levels in ponds 3 and 4 are unusually high. It would appear that the spring water feeding ponds 3 and 4 is naturally high in phosphorus and this was probably the reason for the high concentration of microscopic algae in these two ponds.

Nitrogen levels (Appendix III) in all ponds were quite normal, although ponds 3 and 4 had higher concentrations than ponds 1 and 2. The rather high values for Kjeldahl nitrogen in ponds 3 and 4 simply reflects the amount of nitrogen tied up organically in the algae.

pH

The term "pH" simply refers to the degree of acidity or alkalinity of water. The pH scale goes from 0 (completely acidic) to 14 (completely alkaline) with pH-7 being neutral. In general, natural waters are suitable for fish and other aquatic life when the pH is between 6.5 and 8.5.

pH measurements on the Caledon trout ponds varied from 8.0 to 8.6 (see Appendix I and Appendix III). The pH values were quite high because of the photosynthetic activity of the aquatic plants; however, the values found indicate suitable conditions for aquatic life and recreational usage.

Dissolved Oxygen

A lack of dissolved oxygen in water is probably the most common cause of fish kills. Trout are fairly demanding with respect to dissolved oxygen and are usually the first type of fish to suffocate when the oxygen levels drop.

Concentrations of dissolved oxygen on July 9 were suitable in both surface and bottom water in all four ponds (Appendix I). Values in ponds 1 and 2 were near saturation, while ponds 3 and 4 were very supersaturated because of the high concentrations of algae liberating oxygen during photosynthesis.

Because of the apparent lack of a pronounced vertical stratification of dissolved oxygen and temperature in the ponds, dissolved oxygen concentrations should not be problematical during the ice-free period.

Temperature

The suitability of many ponds for trout production is frequently impaired by high water temperatures. Water temperatures largely determine the over-all rate of biological activity in a pond; in general, a 10°C rise in temperature will double the respiration rate and oxygen demand of fish and other aquatic life. Simultaneously, warmer water decreases the solubility of oxygen.

While the growth and development of rainbow trout apparently were satisfactory, water temperatures in all four ponds (see Appendix I) were well above optimum temperature levels recommended in the literature. The Federal Water Quality Administration (page 43, Water Quality Criteria) in the U.S. has suggested a maximum recommended temperature for the growth and migration of salmonids at 68°F (20°C). Garside and Tait (1958) found the preferred temperature of rainbow trout to be 13°C (55°F).

Temperature measurements made on July 9 revealed that water leaving the system of ponds (24.2°C in pond #2, 22.5°C in pond #3) was from 12.5 to 14.2°C warmer than the spring water (10°C) entering pond #4. This illustrates the detrimental thermal effect that rather large, shallow ponds with a small flushing rate and limited pond-side cover (i.e. shade trees) can have on a watershed. The influence of these and other poorly designed ponds on the Credit River PRODUCE ~~reduce~~ an overall undesirable warming effect and no doubt shorten the length of river suitable for trout production.

Secchi disc

Secchi disc measurements simply provide an indication of the turbidity of water. While a variety of dissolved and suspended solids can reduce water clarity, the degree of turbidity is largely determined by the quantity of phytoplankton. Low secchi disc readings in ponds 3 and 4 were largely due to the dense phytoplankton populations in these ponds.

Visual appearance

The main aesthetic problem in ponds 1,2 and 3 was caused by mats of sludge rising to the surface. This problem was particularly evident in pond 1.

Microscopic examination of this sludge revealed that it was composed of a mixture of diatoms, the blue-green alga *Lyngbia* sp., and decomposing organic debris. The healthy appearance of the *Lyngbia* sp. would suggest that the sludge was buoyed to the surface by the oxygen bubbles produced during photosynthesis. The increase in the quantity of floating sludge on hot, sunny days is likely due to the increased rate of photosynthetic activity which normally occurs under these weather conditions.

As mentioned previously, the water in ponds 3 and 4 was quite turbid and coloured due to the dense phytoplankton populations. The results of samples collected from these ponds for phytoplankton identification are outlined in Appendix IV.

With the exception of shoreline accumulations of duckweed (Lemna minor) in pond 3, there was little evidence of macrophyte growths in ponds 3 and 4. Only small beds of stonewort (Chara sp.) and naids (Najas sp.) were evident in pond 1. However, fairly extensive growths of pondweed (Potamogeton sp.), Najas sp. and Chara sp. were observed in pond 2.

SUMMARY AND RECOMMENDATIONS

Samples collected on July 9 showed that there was no significant bacteriological contamination in pond #1 at the time of sampling. However, due to the seasonal fluctuations in bacterial numbers, samples should be collected on a routine basis (perhaps monthly) and submitted to the Ontario Department of Health for analyses. Also, because of the rather large size of the club and the proximity of the club house to the ponds, it is suggested that an inspector from the Department of Health investigate the adequacy of the club's sewage disposal system.

A main problem in the ponds (particularly ponds 3 and 4) is one of over-production of algae. This is largely a result of three factors:

(a) the high concentration of nutrients (particularly phosphorus)

(b) warm water temperatures

(c) age of the ponds

a) While that part of the watershed flowing through ponds 1 and 2 appeared to have a normal concentration of phosphorus, the phosphorus level in ponds 3 and 4 was undesirably high. Further sampling for phosphorus analyses should be carried out (many consulting firms can test for phosphorus) and if the July 9 results are representative, consideration should be given to reducing the phosphorus in ponds 3 and 4. Phosphorus reduction through chemical precipitation is still in the experimental stages, but the club may wish to contact the OWRC Division of Research for suggestions.

b) The warm water temperatures are typical where large, shallow, unshaded ponds are fed from a small watershed. Future management policies should be directed toward increasing the depth to surface ratio of the ponds, maximizing the number of large shade trees along the shoreline, and providing bottom rather than surface draw-off from each pond.

c) Aging is simply the natural process whereby bodies of water gradually fill in as a result of the solids carried in from inflowing tributaries, and the settling and decomposition of biological materials (e.g. algae). As ponds age, nutrients normally increase in concentration and biological activity is accelerated. In general, this process occurs far more rapidly in small bodies of water. Also, due to warm temperatures, biological productivity in ponds is generally higher and thus larger quantities of organic material are continually settling to the bottom.

Aging can be partially reversed by dredging (to deepen ponds). However, dredging does present some problems such as increased turbidity and a destruction of invertebrate life (fish food organisms) on the pond bottom. Therefore, if a

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decision is made to dredge, it would be advisable to do one pond and observe the results before a decision is made on the other ponds.

A reduction of phosphorus and/or a decrease in water temperature would serve to reduce the rate of aging.

To improve the aesthetic appearance of the ponds we would suggest the following:

1. mechanical removal (i.e. raking) of excessive growths of pondweed (Potamogeton sp.) in pond 2,

2. continuous removal of surface accumulations of sludge through the use of a hand rake or skimmer,

3. the use of algicides can be considered when excessive algae blooms occur. However, a permit must be obtained from the OWRC prior to any chemical treatment.

Dissolved oxygen measurements indicated that there should be no problem during the ice-free period. However, it would be advisable to measure the dissolved oxygen periodically during the winter in case aeration is required at that time.

REFERENCES

GARSIDE, E. T. and TAIT, J. S. Preferred temperature of rainbow trout (Salmo gardnerii Richardson) and its usual relationship to acclimation temperature. Can. J. Zool. 36, 563 (1958).

APPENDIX I

Caledon Mountain Trout Club

- Field Measurements - July 9, 1971.

I. Wile and D. Veal

Pond #1

- sampling location near south end of pond in 9 feet of water

Temperature - telethermometer		pH	Dissolved oxygen (ppm)	Conductivity u mhos/cm^2
0'(surface) -	20.7°C	8.0	10	220
1'	20.5°			
2'	20.3°			
3'	18.4°			
4'	18.4°			
5'	18.4°			
6'	18.4°			
7'	18.4°			
8'	18.4°			
9'	18.5°	8.0	8	

Secchi disc - 4.5 feet

One water sample taken at mid-depth for further chemical analyses

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Pond #2

- sampling location near middle of pond in 10.5 feet of water

Temperature - telethermometer		pH	Dissolved oxygen (ppm)	Conductivity u mhos/cm^2
0'(surface) -	24.2°C	8.5	10	235
1'	24.2°			
2'	23.9°			
3'	22.2°			
4'	21.7°			
5'	21.3°			
6'	21.3°			
7'	21.3°			
8'	21.3°			
9'	21.3°			
10'	21.3°			
10.5	21.3°	8.4	8	

Secchi disc - 7.0 feet

Two water samples taken (surface and bottom) for further chemical analyses.

Pond #3

- sampling location at north-east corner of pond

Temperature - telethermometer		pH	Dissolved oxygen (ppm)	Conductivity u mhos/cm^2
0'(surface) -	22.5°C	8.5	17	215
1'	22.5°			
2'	21.5°			
3'	21.0°			
4'	20.7°		16	

Secchi disc - 2.2 feet

One water sample taken at surface for further chemical analyses

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[illegible]

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[illegible]	[illegible]	[illegible]	[illegible]

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[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

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Pond #4

- sampling location near middle of pond in 7 feet of water

Temperature - telethermometer		pH	Dissolved oxygen (ppm)	Conductivity u mhos/cm^2
0'(surface) -	25.7°C	8.6		215
1'	24.8°			
2'	23.0°			
3'	22.2°			
4'	21.7°			
5'	21.5°			
6'	21.2°			
7'	21.0°		16	

Secchi disc - 2.0 feet

One water sample taken at mid-depth for further chemical analyses.

Station A (see map)

- source of pond #4 (spring water)

Temperature	-	10.0°C
pH	-	7.4
Dissolved oxygen(ppm)	-	9

Station B (see map)

- small pond, just downstream from pond #4

Temperature	-	20.5°C
Dissolved oxygen(ppm)	-	11

Station C (see map)

- small pond, just upstream from pond #3

Temperature	-	22.0°C
Dissolved oxygen(ppm)	-	9

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ONTARIO WATER RESOURCES COMMISSION — DIVISION OF LABORATORIES

BACTERIOLOGICAL REPORT

FILE: Caledon Tsp. - Credit R. headwaters

	SAMPLED D M Y	ANALYSED D M Y	REPORTED D M Y		
DATE:	9 771	12 771	21 771	120874	120875

REPORT TO: D. Veal, Biology Br.

COPY TO:

PARTICULARS:

RESULTS PER 100 ML:

LAB NO.	Particulars		Fecal Coliforms / Streptococcus	Plate Count / Pseudomonas	Background Colonies / Clostridium	Coliform Bacteria
120874	1 Pond #1 Caledon Mtn. Trout Club	120874	FECAL COLIFORMS 1	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA 36
			STREPTOCOCCUS 1	PSEUDOMONAS	CLOSTRIDIUM	
120875	2 Tributary to Pond #1 - Caledon Mtn. Trout Club	120875	FECAL COLIFORMS 12	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA 420
			STREPTOCOCCUS 56	PSEUDOMONAS	CLOSTRIDIUM	
			FECAL COLIFORMS	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA
			STREPTOCOCCUS	PSEUDOMONAS	CLOSTRIDIUM	
			FECAL COLIFORMS	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA
			STREPTOCOCCUS	PSEUDOMONAS	CLOSTRIDIUM	
			FECAL COLIFORMS	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA
			STREPTOCOCCUS	PSEUDOMONAS	CLOSTRIDIUM	
			FECAL COLIFORMS	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA
			STREPTOCOCCUS	PSEUDOMONAS	CLOSTRIDIUM	
			FECAL COLIFORMS	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA
			STREPTOCOCCUS	PSEUDOMONAS	CLOSTRIDIUM	
			FECAL COLIFORMS	PLATE COUNT	BACKGROUND COLONIES	COLIFORM BACTERIA
			STREPTOCOCCUS	PSEUDOMONAS	CLOSTRIDIUM	

APPENDIX II

+ CHLORINE PRESENT

G & L MEANS GREATER THAN & LESS THAN

SEE REVERSE SIDE FOR INTERPRETATION

ONTARIO WATER RESOURCES COMMISSION

CHEMICAL LABORATORIES

All analyses except pH reported in p.p.m. unless otherwise indicated

RIVER SURVEY

1 p.p.m. = 1 mgm. / litre = 1 lb. / 100,000 Imp. Gals.

Municipality: Caledon Township

Report to: Veal/Wile
Biology Br.
Appendix III

c.c. W.Q. Surveys
Central Files

Source: Credit R. Headwaters

Date Sampled: July 9/71 by: Veal/Wile

APPENDIX III

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Lab. No.	Total Phosphorus as P	Free Ammonia as N	Total Kjeldahl as N	Nitrite as N	Nitrate as N	pH at Lab.	Hardness as $CaCO_3$	Copper as Cu					
R28-133	.020	.14	.011	0.28	.80	8.2	214	-					
R28-134	.17	0.01	.001	<0.01	1.8	8.3	184	-					
R28-135	.19	0.01	.001	<0.01	1.3	8.4	206						
R28-136	.034	0.15	.012	0.25	.56	8.2	220	-					
R28-137	.028	0.06	.007	0.34	.40	8.2	226	-					
R28-138	.008	<0.01	.003	0.74	0.25	<	-	-					

R28-133	A.	Caledon Mtn. Trout Club - Pond	#2	Surface
R28-134	B.		#3	"
R28-135	C.		#4	"
R28-136	D.		#2	Bottom
R28-137	E.		#1	Surface
R28-138	F.	100 yds. upstream from pond #1		

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APPENDIX IV

Two samples collected from ponds at the Caledon Mountain Trout Club in Caledon Township on July 9 were submitted for phytoplankton identification.

Sample #71-833 collected from Pond #3 contained large quantities of the pennate diatoms *Navicula* spp., *Synedra* spp., and the filamentous pennates *Melosira* sp. and *Fragilaria* sp. Other algae present included the greens, *Coelastrum* sp. and *Chlorella* sp., the flagellate *Chlamydomonas* spp. and the blue-green *Oscillatoria* spp. Other organisms included protozoa and rotifers. The algae in Sample #71-834 collected from Pond #4 was composed almost entirely of colonies of the green algae *Coelastrum* sp. Other algae present included the greens *Pediastrum* sp. *Chlorella* sp., *Phytoconis* sp., the flagellate *Chlamydomonas* sp. and the diatom *Navicula* sp.